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Segment No. 16-34-02

WA-34-1020

PULLMAN SEWAGE TREATMENT PLANT
CLASS II INSPECTION; SEPTEMBER 16-17, 1986

by

Marc Heffner

Water Quality Investigations Section
Washington State Department of Ecology
Olympia, Washington 98504-6811

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ABSTRACT

A Class II inspection was conducted at the Pullman Sewage Treatment Plant (STP) on September 16 and 17, 1986. The facility, a bio-tower/activated sludge secondary plant discharging into the South Fork of the Palouse River, was providing good biochemical oxygen demand (BOD₅) and total suspended solids (TSS) removal. Reduced effluent ammonia and chlorine residual concentrations were observed in comparison to a pre-upgrade survey conducted in 1978. All parameters were below or within National Pollutant Discharge Elimination System (NPDES) permit limits, with the exception of the effluent ammonia concentration which exceeded the allowed monthly average. Collection of limited receiving water data by STP personnel is suggested to help evaluate the ammonia permit limits.

INTRODUCTION

A Class II inspection was conducted on September 16 and 17, 1986, at the Pullman Sewage Treatment Plant (STP). The inspection was a follow-up to a pre-upgrade Class II inspection/receiving water survey done by the Water Quality Investigations Section (WQIS) on September 12 and 13, 1978 (Bernhardt and Yake, 1979). Conducting the inspection were Carl Nuechterlein from the Ecology Eastern Regional Office (ERO) and Marc Heffner from the Ecology WQIS. Terry Dokken, chief operator at the STP, and Al Prouty, plant process analyst, provided assistance. The inspection was conducted in conjunction with an Ecology receiving water study on the South Fork of the Palouse River. The receiving water results are presented in a separate report (Joy, in preparation).

The Pullman STP is a secondary plant that provides seasonal nitrification. Treatment units include two primary clarifiers, a bio-tower, two activated sludge basins, two secondary clarifiers, and chlorination/dechlorination facilities (Figure 1). Treated effluent is discharged into the South Fork Palouse River, as limited by NPDES permit #WA-004465-2. Sludge from the process is thickened, anaerobically digested, dried using a belt filter press, then spread on agricultural land. A paved lagoon is used for sludge storage when field conditions do not allow spreading.

Objectives included:

1. Collect samples and measure flow to estimate plant efficiency and NPDES permit compliance.
2. Review laboratory procedures (including sample splits with the STP laboratory) to estimate accuracy of results and conformance with approved analytical techniques.
3. Provide data for consideration as part of the receiving water study.



2

PROCEDURES

Grab and composite samples were collected during the inspection. Ecology composite samplers collected influent and effluent samples (Figure 1). The samplers collected approximately 220 mLs of sample every 30 minutes for 24 hours. Composite samples collected by the Pullman STP included a flow-paced influent sample and a time-paced effluent sample. The effluent sampler collected approximately 150 mLs of sample every 45 minutes. The Pullman influent sampler plugged during the sampling period, resulting in an incomplete sample. All composite samples were split for analysis of selected parameters by the Ecology and Pullman STP laboratories. Sampling times and parameters analyzed are included on Table 1.

Ecology grab samples were collected for field and laboratory analyses (Figure 1). Samples collected and parameters analyzed are summarized on Table 1.

Instantaneous Ecology flow measurements were made at the influent Parshall flume. The operator reported that the in-line effluent flow meter is not accurate at the usual plant flow rate, so it was not being used during the inspection.

RESULTS AND DISCUSSION

Data collected during the inspection are summarized in Table 2 (Ecology Analytical Results) and Table 3 (Flow Measurements).

Table 3 - Flow measurements - Pullman, 9/86.

Date			Instantaneous flow (MGD)	Totalizer reading	Flow for
Month	Day	Time			time increment (MGD)
9	16	1150	-	29929	
				*	2.15
9	16	1510	2.80+	2408	
					2.71
9	17	0820	5.78	21770	
					4.82
9	17	1050	3.90	26786	
Average flow during inspection =					2.85

*totalizer reset to zero at approximately 1200 hours each day.

Meter was reset from approximately 30500 on 9/16.

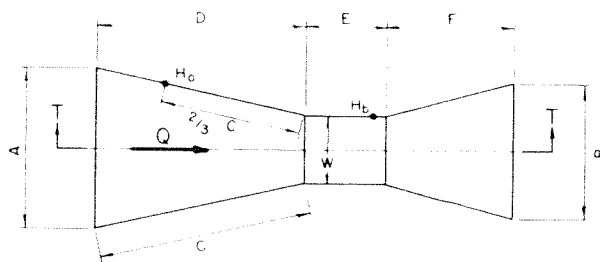
+Ecology instantaneous measurement 2.9 MGD (assumes standard 18" Parshall flume)

Plant Operation

Figure 1 provides a schematic of the plant flow. Influent flow passes through the headworks/flume area into a wet well where it combines with return flows. Measurements of the Parshall flume and head heights were made by Ecology. Table 4 compares the field measurements with specifications for a standard 18-inch Parshall flume. The field measurements indicate that the throat of the flume does not meet standard specifications. Comparison of Ecology instantaneous head height measurements with the instantaneous in-plant flow meter suggests that the meter is calibrated as an 18-inch flume (Table 3). The plant flow measurements are probably slightly higher than the actual flow. The effluent flow meter should be repaired and used. The influent flume can be used as a rough check of effluent flow meter accuracy.

Table 4 - Comparison of STP flume to
standard flume dimensions*
- Pullman, 9/86.

Measurement	Standard dimension (in)+	STP flume (in)
A	40 3/8	40 1/4
B	30	30 3/8
C	57	58 5/8
2/3 C	38	38
E (side 1)	24	21 1/2
E (side 2)	24	20 1/2
W	18	17 1/4**



*standard dimensions and flume diagram
from Stevens (1978)

+for 18" flume

**estimate; walls were bowed so throat
width variable

Flow then passes through the primary clarifiers and into a splitter box where it is combined with the bio-filter return flow. Sludge depth measurements showed sludge accumulation in the primary clarifiers was minimal, ranging from six inches to one foot. From the splitter box a portion of the flow is sent to the bio-tower while the remainder is combined with the return activated sludge (RAS) and sent to the

aeration basins. Bio-tower loading is maintained at approximately 90 lbs BOD₅/D/1000 ft³ of media to avoid odor problems that occur at higher loadings.

Dissolved oxygen (D.O.) concentrations in the aeration basins are maintained at approximately 3.0 mg/L. The high D.O. is maintained to encourage nitrification. Ecology D.O. measurements made on 9/16 at 1040 hours using a YSI D.O. meter ranged from 3.0 to 4.0 mg/L (Table 2); within 0.5 mg/L of the permanent in-tank meters at the plant. The in-tank meters indicated that D.O. concentrations ranged from 2.7 to 4.2 mg/L on 9/17 at 0830 hours. MLSS concentrations were maintained in the 1300-to-1500 mg/L range (Table 2).

Aeration basin effluent is routed to the secondary clarifiers. Sludge depth measurements in the secondary clarifiers ranged from zero to one foot. The clarified effluent is routed to the chlorine contact basin for chlorination followed by dechlorination and discharge into the South Fork of the Palouse River. Sludge depth at the tail end of the chlorine contact chambers ranged from 1.5 to 1.75 feet in 6 feet of water. Al Prouty reported that the basin had been cleaned the week before, indicating fairly rapid deposition.

The chlorination/dechlorination process is a flow proportional system tied into the influent flow meter (it was tied into the effluent flow meter until meter inaccuracies were discovered). The chlorine residual concentration is monitored at two locations. A sensor at the head end of the contact basin continuously monitors the concentration and controls the chlorine dosing rate. A sensor at the tail end monitors the chlorine residual prior to dechlorination and controls the rate of SO₂ addition. Every two hours the tail end meter switches to a sensor located after dechlorination which monitors the actual discharge concentration for 15 minutes. Al Prouty reported that meter precision is approximately ± 0.06 mg/L, greater than the permitted 0.02 mg/L effluent concentration.

Sludge handling at the plant involves several processes. Sludge from the primary clarifier is gravity thickened while waste activated sludge (WAS) is thickened using dissolved air flotation. The two thickened sludges are mixed then anaerobically digested. The digested sludge is dewatered using a belt filter press. The dried sludge is applied on agricultural land. A paved holding lagoon is used to store the dried sludge for later land application when immediate application is not possible.

Data Analysis

The inspection data show that good BOD₅ and TSS reductions were occurring (Table 2). Table 5 compares inspection data with applicable design capacity data from the NPDES permit. Although the inspection flow was slightly greater than the dry-weather design, the BOD₅ and TSS loads were far enough below capacity that the plant appears well within design capacity.

Table 5 - Comparison of inspection data to NPDES permit design criteria - Pullman, 9/86.

	Permit Design Capacity	Inspection Data*
Monthly average - dry-weather flow (MGD)	2.7	2.85
Influent BOD ₅ loading (lbs/D)	6000	4300
Influent TSS loading (lbs/D)	6100	3100

*Ecology analysis of Ecology composite samples.

The influent was unusually dark when the 1030 hours grab sample was collected on September 16. Laboratory analysis found the sample to be highly colored (1800 units), with a slightly elevated TSS concentration (400 mg/L) and typical COD (Table 2). Determining the source of the discoloration was not pursued.

Table 6 compares data collected prior to the upgrade with inspection data (Bernhardt and Yake, 1978). Effluent quality improvements in NH₃-N and chlorine residual concentrations are most noticeable. The higher BOD₅ effluent concentration observed during the 1986 inspection is probably due to nitrification during the test as the inhibited BOD₅ (CBOD₅) was approximately 13 mg/L less than the BOD₅ (Table 2).

The difference between the BOD₅ and CBOD₅ would likely increase during spring when the plant begins to nitrify, and fall when nitrification slows down. Pullman should consider running both BOD₅ and CBOD₅ tests on effluent samples to determine how much of a problem nitrogenous oxygen demand is during the test. If the problem causes difficulty meeting the BOD₅ permit limit, they may wish to request CBOD₅ effluent limits.

Comparison of inspection data with NPDES permit limits is presented in Table 7. All parameters were within monthly permit limits except the NH₃-N effluent concentration. Possible methods to attain additional NH₃-N removal with the present facility include:

1. Additional BOD removal by the bio-tower may encourage additional nitrification in the aeration basins. This may not be practical because the bio-tower is presently being loaded at the maximum rate at which nuisance odors do not occur.
2. Increase MLSS concentrations in the aeration basins to encourage a higher sludge age and thus encourage a higher population of nitrifying organisms. Operator experimentation could determine the practicality of a higher MLSS.

Table 6 - Comparison of 1978* and 1986 inspection data - Pullman, 9/86.

Station	Date	Sample Type	Total Chlorine Residual (mg/L)	Fecal Coliform (#/100 mL)	BOD ₅ (mg/L)	COD (mg/L)	Solids (mg/L)				Turbidity (NTU)	Nutrients (mg/L)					Conductivity (umhos/cm)	Flow (MGD)
							TS	TNVS	TSS	TNVS		NH ₃ -N	NO ₂ -N	NO ₃ -N	O-PO ₄ -P	Total-P		
Influent	9/16-17/86	Comp.			180	400	620	330	130	20	32	0.01	0.07	3.1	6.4	740	2.85	
	9/12-13/78				136	329	635	341	190	54	72	<0.02	<0.02	3.2	5.9	612	2.66	
Effluent	9/16-17/86	Comp.			17+	44	490	300	7	<1	3	1.3	24	5.8	7.0	652		
	9/12-13/78				<4	67	368	289	5	2	4	<0.02	<0.02	3.0	3.3	593		
	9/16-17/86	Grab	<0.1	71-200														
	9/12-13/78		1.5-1.6	10 est.														

* = 1978 data from Bernhardt and Yake (1979)

est. = estimated

+ = inhibited BOD₅ - 4.1 mg/L

Table 7 - Comparison of inspection data to NPDES permit limits -
Pullman, 9/86.

Parameter	NPDES Permit Limits		Inspection Data+		
	Monthly Average	Weekly Average	Ecology Composite	STP Composite	Grab Samples
BOD ₅					
(mg/L)	30	45	17	18	
(lbs/D)	900	1350	404	428	
(% removal)	85		91	*	
TSS					
(mg/L)	30	45	7	6	
(lbs/D)	915	1373	166	143	
(% removal)	85		95	*	
Fecal coliform (#/100 mL)	200	400			160;200; 160;71
pH (S.U.)	6.0 ≤ pH ≤ 9.0				7.0;7.0
Flow (MGD)	4.3		2.85	2.85	
NH ₃ -N (mg/L)					
(12/1 - 3/30)	-				
(4/1 - 4/30)	5				
(5/1 - 10/30)	1		2.0	1.9	
(11/1 - 11/30)	5				
Chlorine residual (mg/L)	<0.02				<0.1

+Ecology laboratory analyses

*Influent compositor malfunction prevented calculation

3. Improving the environment in the aeration basins may encourage further nitrification. High D.O. concentrations are maintained in the basins to encourage maximum growth rates (2.7 to 4.2 mg/L during the inspection). The pH should also be considered. Effluent pH during the inspection was 7.0 and the alkalinity was 120 mg/L. Maximum nitrification is thought to occur in the pH range of 7.2 to 9.0 (Metcalf and Eddy, 1979). When using fine bubble diffusers, maintaining an alkalinity of 175 mg/L as CaCO_3 is predicted as necessary to keep the pH at 7.2 (EPA, 1975). Review of effluent pH data from several months of DMR data is presented in Table 8. The data suggest that pH may be inhibiting nitrification at the plant. Monitoring pH and alkalinity in the secondary system and adjusting as necessary may improve nitrification efficiency.

Table 8 - DMR Effluent pH Data - Pullman, 9/86.

Date	pH range (S.U.)
6/86	6.4 - 7.1
5/86	6.4 - 7.0
4/86	6.4 - 6.8
3/86	7.0 - 7.3
2/86	6.3 - 7.0
1/86	6.6 - 7.0
12/85	6.4 - 7.0

The $\text{NH}_3\text{-N}$ permit limits were reviewed to estimate the $\text{NH}_3\text{-N}$ toxicity protection provided in the receiving water. The one-hour and four-day $\text{NH}_3\text{-N}$ toxicity criteria for the South Fork of the Palouse River were calculated using Ecology ambient water quality monitoring data from station 34B110 located at the State Street bridge upstream of the STP (EPA, 1986; Ecology, 1986). Individual criteria were calculated for each monthly sample collected in water years 1982-1986. The allowable $\text{NH}_3\text{-N}$ concentration in the STP effluent at which the criteria would not be exceeded was then calculated for the inspection and maximum permitted flow rates. Figures 2-5 compare the allowable effluent concentrations to the existing permit limits. Applicable formulas and calculations are provided in Appendix I.

The figures suggest the existing permit limits usually provide adequate one-hour criteria protection, but often fail to provide adequate four-day protection. Unfortunately, downstream ambient receiving water data are not available to more accurately estimate actual toxicity criteria. Receiving water data collected during the inspection showed the effluent significantly changes receiving water pH and temperature, decreasing $\text{NH}_3\text{-N}$ toxicity in the receiving water (Joy, 1987). Table 9 summarizes $\text{NH}_3\text{-N}$ toxicity-related changes near the STP.

Collection of upstream (State Street Bridge) and downstream (Old City Dump Road Bridge) pH and temperature data on a routine basis by STP personnel is suggested so $\text{NH}_3\text{-N}$ effluent limits can be properly

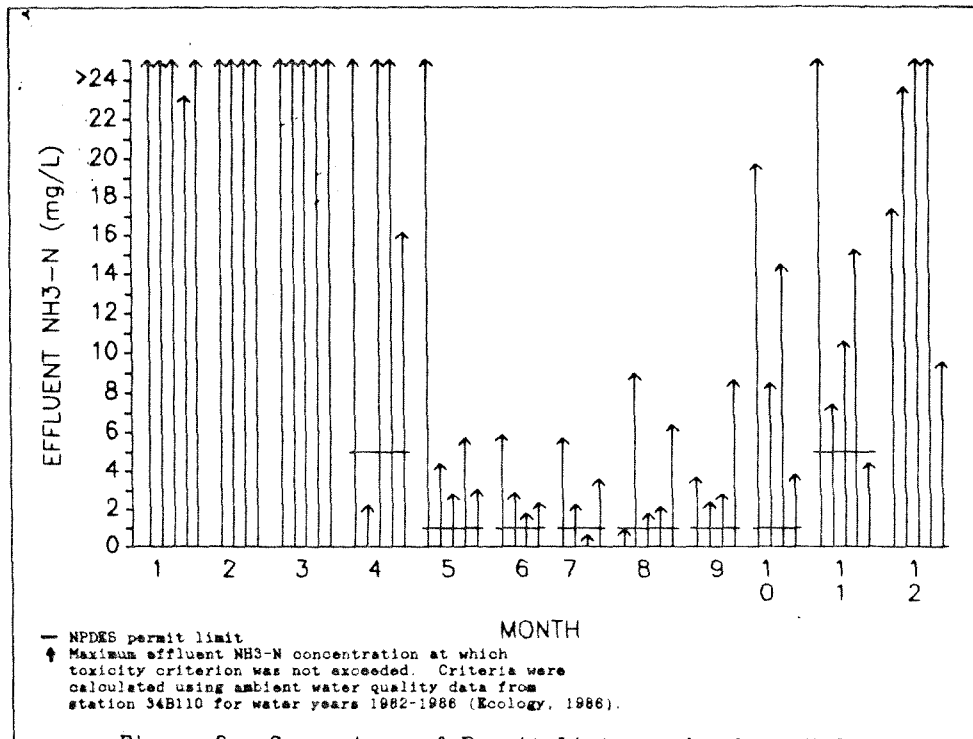


Figure 2 - Comparison of Permit Limits and 1-hour NH3-N Toxicity Criteria at the Inspection Flow Rate - Pullman, 9/86.

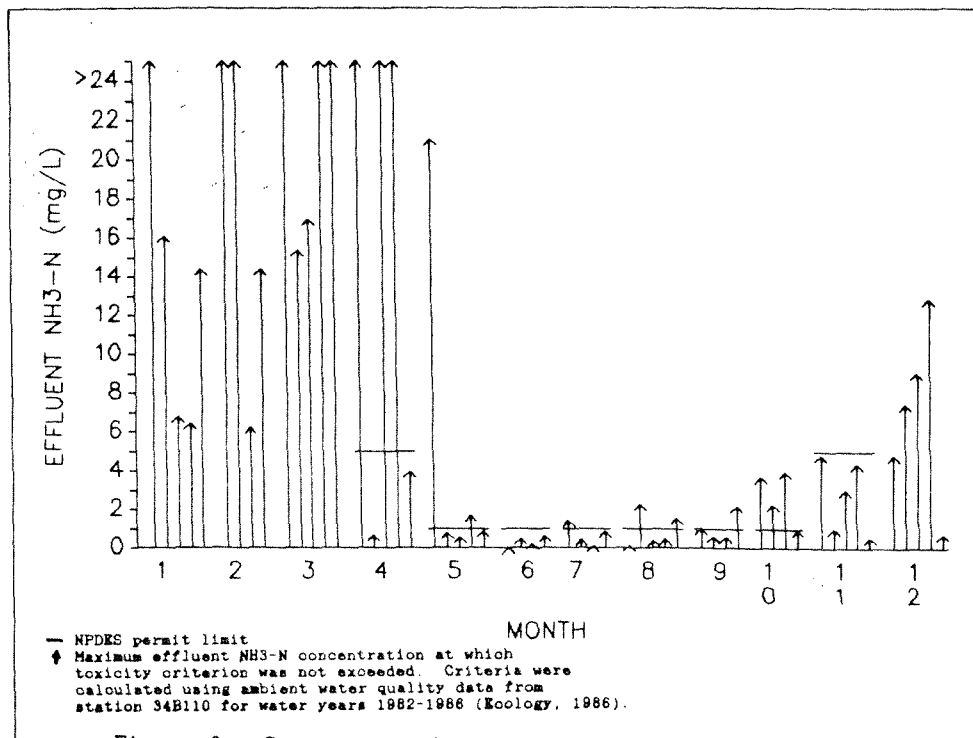


Figure 3 - Comparison of Permit Limits and 4-day NH3-N Toxicity Criteria at the Inspection Flow Rate - Pullman, 9/86.

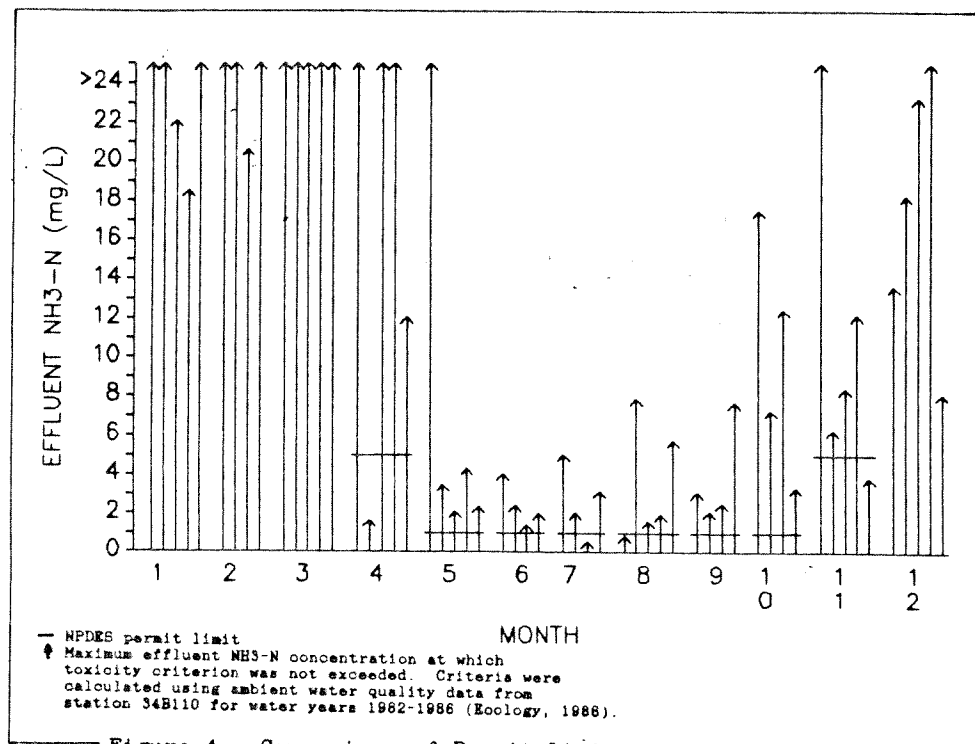


Figure 4 - Comparison of Permit Limits and 1-hour NH3-N Toxicity Criteria at the Maximum Permitted Effluent Flow Rate - Pullman, 9/86.

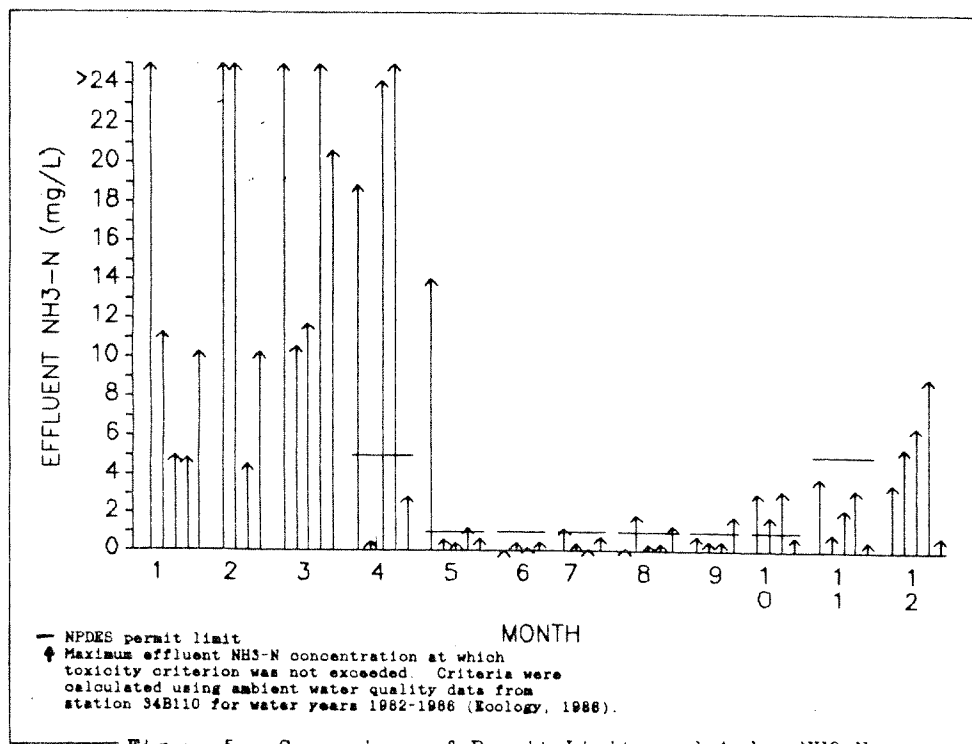


Figure 5 - Comparison of Permit Limits and 4-day NH3-N Toxicity Criteria at the Maximum Permitted Effluent Flow Rate - Pullman, 9/86.

Table 9 - Upstream and Downstream Ammonia Toxicity Criteria Comparison* - Pullman, 9/86.

Station	Date	Time	Temp. (°C)	pH (S.U.)	Percent un-ionized NH ₃ -N	Toxicity Criteria (mg/L un-ionized NH ₃ -N)		Toxicity Criteria (mg/L NH ₃ -N)	
						1-hour	4-day	1-hour	4-day
Upstream**	9/16	1400	15.6	7.9	2.22	0.150	0.029	6.8	1.3
Downstream**	9/16	1230	18.1	7.5	1.08	0.131	0.019	12.1	1.8
Upstream**	9/17	1010	12.3	7.9	1.74	0.119	0.023	6.8	1.3
Downstream**	9/17	0930	17.0	7.3	0.63	0.096	0.011	15.2	1.8

*Data from Joy (in preparation)

**Upstream samples taken at State St. Bridge; downstream samples taken at Old City Dump Road Bridge

reviewed and changed as necessary. Collection of data two times per day (early morning and midafternoon) once per week should be adequate.

The dechlorination system deserves further analysis. Al Prouty reported that the maximum SO_2 injection rate is 24 lbs/D. At the peak flow rate measured during the inspection (5.78 MGD), that rate would be adequate to remove a chlorine residual of 0.5 mg/L (calculation assumes 1 mg/L SO_2 removes 1 mg/L chlorine residual; WPCF, 1977). Ecology chlorine residual concentration measurements roughly corresponding to the peak flow rate were 0.3 mg/L prior to dechlorination and <0.1 mg/L after chlorination. Reserve capacity of the SO_2 system appears minimal; an increase should be considered in the near future.

Metals analysis results from the digested sludge sample are presented in Table 10. The results indicate that the Pullman STP sludge was within the range of concentrations found at activated sludge plants statewide during previous Class II inspections.

Table 10 - Sludge metals data - Pullman, 9/86.

Metal	STP Sample** (mg/kg dry wt)	Summary of Statewide Data*		
		Range (mg/kg dry wt)	Geometric Mean (mg/kg dry wt)	Number of Samples
Cadmium	5.0	<0.1 - 25	6.9	28
Chromium	62	15 - 300	60	28
Copper	426	75 - 1700	370	28
Lead	90	34 - 600	220	28
Nickel	22	<0.1 - 62	22	24
Zinc	890	165 - 3370	1160	28

*summary of data collected during previous Class II inspections at activated sludge plants throughout the state

**percent solids = 27%

Laboratory Procedures Review

Laboratory procedures were reviewed with Pullman STP staff by Ecology roving operator Otis Hampton. A copy of the "Laboratory Procedural Survey" he completed is included in Appendix II.

Results of samples split for analysis by both the Ecology and Pullman STP laboratories are presented on Table 11. Results for most samples compare closely, although the Pullman STP TSS results were greater in all cases. Completed TSS test filters should be redried and reweighed to assure they are being adequately dried. Once adequate drying is assured, quarterly rechecks using the redry/reweigh technique are suggested for quality assurance.

Table 11 - Comparison of split sample laboratory results -
Pullman, 9/86.

Station	Sampler	Laboratory	BOD ₅ (mg/L)	TSS (mg/L)	NH ₃ -N (mg/L)
Influent	Ecology	Ecology	180	130	19
		Pullman	202	152	22
	Pullman*	Ecology	250	250	24
		Pullman	275	282	21
Effluent	Ecology	Ecology	17	7	2.0
		Pullman	19	12	2.2
	Pullman	Ecology	18	6	1.9
		Pullman	24	14	2.2

*compositor malfunction prevented collection of a complete sample

RECOMMENDATIONS AND CONCLUSIONS

The STP was providing good BOD₅ and TSS removals, and substantial nitrification during the inspection. Effluent parameters were below or within NPDES permit limits with the exception of the NH₃-N concentration which was greater than the allowed monthly limit. Increasing MLSS concentrations and/or controlling pH in the aeration basins may increase NH₃-N removal. Comparison of the permitted ammonia discharge to receiving water toxicity criteria was inconclusive due to pH and temperature impacts the discharge has on the receiving water. Limited receiving water monitoring by STP personnel as outlined in the discussion is recommended.

Other areas discussed that may need further attention include:

1. The throat of the influent Parshall flume being used for flow monitoring was not standard, likely decreasing accuracy. Repair and use of the in-line effluent flow meter is suggested.
2. Sludge seemed to be accumulating rather quickly in the chlorine contact chambers. Frequent monitoring and sludge removal as necessary are suggested.
3. Preliminary calculations suggest that the capacity of the SO₂ injection system is being approached during daily peak flows. Capacity should be checked and increased if necessary.
4. The difference between the BOD₅ and CBOD₅ test results in the effluent suggests that the nitrogenous oxygen demand may influence the BOD₅ test. The city should consider running side-by-side BOD₅ and CBOD₅ tests, especially during transition periods in and out of nitrification, to see if they should pursue any CBOD₅ permit limits.

Sample splits suggested that the STP laboratory was analyzing samples accurately. Checks to assure that TSS filters are completely dried during the analysis are suggested.

REFERENCES

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APPENDIX I

Calculation of $\text{NH}_3\text{-N}$ toxicity information. Appropriate formulas taken from EPA (1986).

$$\text{1-hour criteria (mg/L un-ionized } \text{NH}_3\text{-N)} = \frac{0.52}{\text{FT} \times \text{FPH} \times 2} \times 0.822$$

where:

$$\text{FT} = 10^{0.03(20-T)}$$

$$\begin{aligned} \text{FPH} &= 1 \text{ if } 8 < \text{pH} < 9^* \\ &= \frac{1 + 10^{(7.4 - \text{pH})}}{1.25} \text{ if } 6.5 \leq \text{pH} \leq 8 \end{aligned}$$

$$\text{4-day criteria (mg/L un-ionized } \text{NH}_3\text{-N)} = \frac{0.80}{\text{FT} \times \text{FPH} \times \text{ratio}} \times 0.822$$

where:

$$\text{Ratio} = 16 \text{ if } 7.7 \leq \text{pH} \leq 9^*$$

$$= \frac{24 \times 10^{(7.7 - \text{pH})}}{1 + 10^{(7.4 - \text{pH})}} \text{ if } 6.5 \leq \text{pH} \leq 7.7$$

Flow rates for calculating the maximum downstream load = SF Palouse flow + STP flow.

	Criteria	
	1-hour	4-day
Inspection flow (MGD)	6	2.85
Maximum permitted flow (MGD)	9	4.3

*An FPH of 1 and a ratio of 16 were used when the pH exceeded 9.0.

Table 1a (cont'd) - Calculation of acceptable NH3-N discharge concentrations for SIP design flow conditions - Pullman, 9/86.

Criteria calculations																

un-ionized NH3-N (lbs/d)																

allowable SIP effluent concentrations (ug/L)																

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Table 1b - Calculation of acceptable NH3-N discharge concentrations
STP inspection conditions - Pullman 9/86.

STP inspection conditions - Pullman 9/86.																			
Criteria calculations										un-ionized NH3-N (lbs/d)									
SF Palouse ambient data										Criteria									
un-ionized NH3-N (mg/L)										un-ionized NH3-N (mg/L)									
un-ionized NH3-N (mg/L)										un-ionized NH3-N (mg/L)									
un-ionized NH3-N (mg/L)										un-ionized NH3-N (mg/L)									
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Table 1b (cont'd) - Calculation of acceptable NH3-N discharge concentrations
SIP inspection conditions - Pullman 9/86.

SIP inspection conditions - Pullman 9/86.														Criteria calculations																																			
														1 hour				4 day				un-ionized NH3-N (lbs/d)																											
														Criteria				Criteria				ratio				STP				allowable S/P effluent concentrations (mg/L)																			
														un-ionized				un-ionized				downstream				upstream				allotance				un-ionized NH3-N				NH3-N											
														NH3-N				NH3-N				1 hour				4 days				1 hour				4 days				1 hour				4 day							
														FT				Ratio				FT				1 hour				4 days				1 hour				4 day				1 hour				4 day			
														un-ionized				un-ionized				un-ionized				un-ionized				un-ionized				un-ionized				un-ionized				un-ionized							
														NH3-N				NH3-N				NH3-N				NH3-N				NH3-N				NH3-N				NH3-N				NH3-N							
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														FT				Ratio				FT				1 hour				4 days				1 hour				4 day				1 hour				4 day			
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APPENDIX II

LABORATORY PROCEDURAL SURVEY

Discharger: City of Pullman

NPDES Permit Number: WA-00-4465-2

Date: 9-16-86

Industrial/Municipal Representatives Present: al prouty, Terry Deffen

Agency Representatives Present: Carl N., Larry P., Mark H.
Otis H.

I. COMPOSITE SAMPLES

A. Collection and Handling

1. Are samples collected via automatic or manual compositing method? automatic, Model? Quality Control Equip. Co. Century 2000

a. If automatic, are samples portable 2 or permanently installed X 2?

Comments/problems MICROPROCESSOR DRIFTS
BL-program occasionally.

2. What is the frequency of collecting composite samples? Inf. proportional to flow. EFF. - 45 min. approx. 1/hr

3. Are composites collected at a location where homogeneous conditions exist?

a. Influent? Yes

b. Final Effluent? Yes

c. Other (specify)? _____

4. What is the time span for compositing period? 24 hr

Sample aliquot? 150 mls per 45 minutes

5. Is composite sample flow or time proportional? Inf - proportional
EFF - Time

6. Is final effluent composite collected from a chlorinated or non-chlorinated source? de-chlorinated
SO₂
7. Are composites refrigerated during collection? yes
8. How long are samples held prior to analyses? 2 - 4 hours
9. Under what condition are samples held prior to analyses?
- a. Refrigeration? X
 - b. Frozen? _____
 - c. Other (specify)? _____
10. What is the approximate sample temperature at the time of analysis? 20 °C
11. Are compositor bottles and sampling lines cleaned periodically?
- yes bottles - after each use
- a. Frequency? lines - 2 months
 - b. Method? bottles - phosphate - Alconox
lines - bleach, sponge through line.
12. Does compositor have a flushing cycle? yes
- a. Before drawing sample? yes
 - b. After drawing sample? yes
13. Is composite sample thoroughly mixed immediately prior to withdrawing sample? _____

Recommendations:

use a calcium Hypochlorite solution For cleaning bottles.

II. BIOCHEMICAL OXYGEN DEMAND CHECKLIST

A. Technique

1. What analysis technique is utilized in determining BOD₅?

a. Standard Methods? X Edition? _____

b. EPA? _____

c. A.S.T.M.? _____

d. Other (specify)? _____

B. Seed Material

1. Is seed material used in determining BOD? yes

2. Where is seed material obtained? SEC. EFF.

3. How long is a batch of seed kept? 2-4
24 hours
and under what conditions? (temperature, dark) _____

4. How is seed material prepared for use in the BOD test? _____

directly to bottles

Recommendations:

Collect seed material the day before analysis.

Collect seed from primary.

C. Reagent Water

1. Reagent water utilized in preparing dilution water is:

- a. Distilled? X
- b. Deionized? _____
- c. Tap _____, chlorinated _____ non-chlorinated _____
- d. Other (specify)? _____

2. Is reagent water aged prior to use? 2 days

How long? _____, under what conditions? _____

in the incubator (dark)

Recommendations:

D. Dilution Water

1. Are the four (4) nutrient buffers added to the reagent water?

yes

a. 1 mls of each nutrient buffer per 1000 mls of reagent water

2. When is phosphate buffer added (in relation to setting up BOD test)? 24 hours in advance

3. How often is dilution water prepared? each time BOD's are set up
Maximum age of dilution water at the time test is set up.

1 day

4. Under what conditions is dilution water kept? _____

excess thrown away

5. What is temperature of dilution water at time of setup? 20°C

Recommendations:

Add phosphate buffer on day of analysis

E. Test Procedure

1. How often are BOD's being set up? 1/4 days

What is maximum holding time of sample subsequent to end of composite period? 2-4 hours

2. If sample to be tested has been previously frozen, is it reseeded? NA How? _____

3. Does sample to be tested contain residual chlorine? NO
If yes, is sample

a. Dechlorinated? _____
How? _____

b. Reseeded? yes
How? sec. effluent

4. Is pH of sample between 6.5 and 8.5? yes approx. 6.9
If no, is sample pH adjusted and sample reseeded? _____

5. How is pH measured? Orion model no. 301

a. Frequency of calibration? daily

b. Buffers used? 4, 7, 9

6. Is final effluent sample toxic? no

7. Is the five (5) day DO depletion of the dilution water (blank) determined? yes, normal range? 0 - 0.2 mg/L
8. What is the range of initial (zero day) DO in dilution water blank? 6.8 - 7.6 mg/L
9. How much seed is used in preparing the seeded dilution water?
25 ml
10. Is five (5) day DO depletion of seeded blank determined? yes
If yes, is five (5) day DO depletion of seeded blank approximately 0.5 mg/l greater than that of the dilution water blank?
no
11. Is BOD of seed determined? yes
12. Does BOD calculation account for five (5) day DO depletion of
a. Seeded dilution water? yes
How? seed correction factor in std. methods
b. Dilution water blank? no 0.1 - 0.2 depletion
How? _____
13. In calculating the five (5) day DO depletion of the sample dilution, is the initial (zero day) DO obtained from
a. Sample dilution? X
b. Dilution water blank? _____
14. How is the BOD₅ calculated for a given sample dilution which has resulted in a five (5) day DO depletion of less than 2.0 ppm or has a residual (final) DO of less than 1.0 ppm? _____
discard
15. Is liter dilution method or bottle dilution method utilized in preparation of
a. Seeded dilution water? bottle liter
b. Sample dilutions? bottle
16. Are samples and controls incubated for five (5) days at 20°C ± 1°C and in the dark? yes

17. How is incubator temperature regulated? temp controlled thermostat
18. Is the incubator temperature gage checked for accuracy? _____
- a. If yes, how? thermometer in flask of H₂O
- b. Frequency? weekly
19. Is a log of recorded incubator temperatures maintained? yes
- a. If yes, how often is the incubator temperature monitored/checked? weekly
20. By what method are dissolved oxygen concentrations determined?
- Probe X Winkler calibrated Other _____
- a. If by probe:
1. What method of calibration is in use? check with Winkler and air calibration every 4 days
 2. What is the frequency of calibration? weekly with Winkler 4 days
- b. If by Winkler:
1. Is sodium thiosulfate or PAO used as titrant? thio.
 2. How is standardization of titrant accomplished? Bi-iodate
 3. What is the frequency of standardization? 4-5 weeks

Recommendations:

calibrate pH meter every 2 hours. Buffer 4, 7, 10

aerate dilution water to raise DO to 8.0-9.0 mg/L

8.5 is super saturation at this elev. 2300 FT.

Standardize thio every 2 weeks.

purchase 16th Ed. of Standard Methods.

F. Calculating Final Biochemical Oxygen Demand Values Washington State Department of Ecology

1. Correction Factors

a. Dilution factor:

$$= \frac{\text{total dilution volume (ml)}}{\text{volume of sample diluted (ml)}}$$

b. Seed correction:

$$= \frac{(\text{BOD of Seed})(\text{ml of seed in 1 liter dilution water})}{1000}$$

c. F factor ~ a minor correction for the amount of seed in the seeded reagent versus the amount of seed in the sample dilution:

$$F = \frac{[\text{total dilution volume (ml)}] - [\text{volume of sample diluted ml}]}{\text{Total dilution volume, ml}}$$

2. Final BOD Calculations

a. For seed reagent:

$$(\text{seed reagent depletion-dilution water blank depletion}) \times \text{D.F.}$$

b. For seeded sample:

$$(\text{sample dilution depletion-dilution water blank depletion-scf}) \times \text{D.F.}$$

c. For unseeded sample:

$$(\text{sample dilution depletion-dilution water blank depletion}) \times \text{D.F.}$$

3. Industry/Municipality Final Calculations

Recommendations:

III. TOTAL SUSPENDED SOLIDS CHECKLIST

A. Technique

1. What analysis technique is utilized in determining total suspended solids?

- a. Standard Methods? X Edition _____
- b. EPA? _____
- c. A.S.T.M.? _____
- d. Other (specify)? _____

B. Test Procedure

1. What type of filter paper is utilized:

- a. Reeve Angel 934 AH? X
- b. Gelman A/E? _____
- c. Other (specify)? _____
- d. Size? _____

2. What type of filtering apparatus is used? _____

Parameter Test
Each Crucible, Whatman no. 1 Routine m/s etc

3. Are filter papers prewashed prior to analysis? yes

- a. If yes, are filters then dried for a minimum of one hour yes at 103°C-105°C yes?
- b. Are filters allowed to cool in a dessicator prior to weighing? yes

4. How are filters stored prior to use? in dessicator
5. What is the average and minimum volume filtered? Raw 20 ml EFF- 50 ml
6. How is sample volume selected?
- Ease of filtration? X
 - Ease of calculation? _____
 - Grams per unit surface area? _____
 - Other (specify)? _____
7. What is the average filtering time (assume sample is from final effluent)? 1.0 minute
8. How does analyst proceed with the test when the filter clogs at partial filtration? discard
9. If less than 50 milliliters can be filtered at a time, are duplicate or triplicate sampe volumes filtered? yes
10. Is sample measuring container; i.e., graduated cylinder, rinsed following sample filtration and the resulting washwater filtered with the sample? yes
11. Is filter funnel washed down following sample filtration? When using millipore
12. Following filtration, is filter dried for one (1) hour, cooled in a dessicator, and then reweighed? yes
13. Subsequent to initial reweighing of the filter, is the drying cycle repeated until a constant filter weight is obtained or until weight loss is less than 0.5 mg? no

14. Is a filter aid such as cellite used? no

a. If yes, explain: _____

Recommendations:

dry & re-weigh FILTER paper to attain a constant
WT.

C. Calculating Total Suspended Solids Values Washington State
Department of Ecology

A. $\text{mg/l TSS} = \frac{A-B}{C} \times 10^6$

1. Where: A = final weight of filter and residue (grams)

B = initial weight of filter (grams)

C = Milliliters of sample filtered

2. Industry/Municipality Calculations

Recommendations:

SPLIT SAMPLE RESULTS:

Origin of Sample _____

Collection Date _____

BOD		TSS		EPA BOD Standard	
<u>DOE</u>	<u>IND./MUN.</u>	<u>DOE</u>	<u>IND./MUN.</u>	<u>DOE</u>	<u>IND./MUN.</u>
_____	_____	_____	_____	_____	_____